

## ABSTRACT

### Two-Photon Interferometry for High-Resolution Imaging Dmitry Strekalov

Classical optical lithography technology is facing its limit due to the classical optical diffraction effect. The minimum width of the diffraction pattern one can achieve, in idealized cases, is one half of the light wavelength,  $\lambda/2$ . However, this classical limit can be surpassed, surprisingly, by utilizing the quantum-entangled states. In this case, the minimum width of the N-photon diffraction or interference pattern can be improved by a factor of N, i.e. reduced down to  $\lambda/2N$ . The working principle of the effect has been demonstrated theoretically by Dowling's group at JPL [Boto 2000], and experimentally, for N=2, by Shih's laboratory at UMBC [unpublished; see Fig. 2]. We propose a novel high-resolution lithography method based on utilizing the special quantum entanglement property of the two-photon, and possibly of three-photon and N-photon ( $N>3$ ) states produced in nonlinear optical interactions. One of the primary benefits of our quantum approach is that one can etch features that are substantially smaller than the optical wavelength, eliminating the need to go to a smaller wavelength of light. It is the quantum correlation that produces the enhancement in resolution via the higher-order (N-photon) interference, while each photon still propagates at its intrinsic (larger) wavelength. This remarkable fact brings about two beneficial aspects, in addition to enhanced spatial resolution.

First, the old optical elements still work. This is important because it is costly and difficult to build quality optics able to handle the short-wave radiation, and these difficulties become progressively harder for shorter wavelengths.

Second, perhaps more important, is that the N-photon sensitive emulsions can be made quite transparent for the single photon wavelength. Therefore thick films can be developed under uniform light conditions, which is very important for creating 3-D structures.